

## METHOD OF STERILIZING POULTRY MEAT

### BACKGROUND OF THE INVENTION

#### Field of the Invention

5           The present invention relates to a method of sterilizing poultry meat.

#### Discussion of the Related Art

10           There are periodic reports on generation of food poisoning associated with poultry meat in many of countries every year. The main causation thereof is microorganism pollution, namely the pollution caused by pathogenic bacteria such as *Salmonella spp.*, *Staphylococcus aureus*, *Clostridium perfringens*, *Campylobacter spp.*, *Bacillus Cerius*, *Shigella spp.* and the like.

15           In general, control of microorganisms in the poultry processing has been difficult. This is due to existence of problems in the poultry processing which are different from those in the case of other edible animals, such that microorganisms are easily diffused due to high-speed treatment of a lot of poultry, that slaughtered bodies are left as a whole during the processing, that it is difficult to remove viscera through a relatively small opening in the abdomen without damaging intestine, that it is difficult to eliminate microorganisms due to  
20           the presence of skin, and that a large number of holes are formed after defeathering.

25           Microorganism pollution of a poultry meat product occurs during transportation of poultry or at any stages in the poultry processing, and microorganisms are also brought to the product from air, water for the processing, ice, apparatus and operating persons. A general example of poultry processing

steps is shown in Figure 1. Control of microorganisms in these processing steps is generally carried out by adjustment of temperature and pH of water for the processing, maintenance of working environments, temperature control in storage and transportation, and the like. A high-pressure spraying, chlorine or the like is used particularly in steps of defeathering, evisceration and chilling among the processing steps, which is concretely used in (1) a method comprising adding sodium hypochlorite to chilled water to be used in a chilling step; (2) a method comprising spraying a mixed solution of sodium hypochlorite and an organic acid before a chilling step; (3) a method comprising immersing into or spraying a mixed solution of a tertiary phosphate and an organic acid before a chilling step; and (4) a method comprising spraying sodium hypochlorite or an analogous chlorine-based bactericide after a chilling step.

However, although the method (1) has an effect on sterilization of bacteria in water and is effective for prevention of cross contamination, the method is insufficient for sterilization of bacteria deposited to the surface of poultry meat because chlorine is inactivated rapidly when chlorine contacts with poultry meat, and consequently, poultry meat is shipped with bacteria remaining. Although the method (2) has a high sterilization effect, there is a risk of generation of a harmful chlorine gas. Therefore, there is a risk that the gas affects detrimentally on human body and equipments. Further, since a bactericide is removed in the chilling step, a sterilization effect cannot be expected in steps after the chilling step. The method (3) has problems of environmental pollution by phosphorus and a detrimental effect on taste of poultry meat. While the method (4) has a high sterilization effect, elimination of a bactericide from poultry meat is

required due to toxicity of the bactericide itself. Therefore, a sterilization effect cannot be expected in steps after the sterilization step.

Conventional methods of sterilizing poultry meat exhibit a sterilization effect only in given steps of poultry processing for the production of poultry meat, and cannot exhibit the effect continuously in steps after a chilling step.

Therefore, although a sterilization treatment is carried out, bacterial pollution and proliferation are again permitted in steps after a chilling step, so that sterilization of a product poultry meat may be insufficient in some cases. Therefore, there has been desired the development of a method of sterilizing poultry meat which can continuously and effectively exhibit a sterilization effect particularly in steps after the chilling step.

An object of the present invention is to provide such a method of sterilizing poultry meat, and more specifically, to provide a method of sterilizing poultry meat capable of sterilizing poultry meat safely and simply, and continuously and effectively.

These and other objects of the present invention will be apparent from the following description.

### SUMMARY OF THE INVENTION

As a result of intensive studies in view of solving the above problems, the present inventor has found that the contact treatment of poultry meat with an aqueous hinokitiol solution effectively solves the above problems. The present invention has been perfected thereby.

According to the present invention, there are provided:

- (1) a method of sterilizing poultry meat comprising the step of subjecting

poultry meat to a contact treatment with an aqueous hinokitiol solution in poultry processing for a production of poultry meat; and

(2) a method for producing poultry meat comprising the step of sterilizing poultry meat by the method according to item (1) above in poultry processing.

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### BRIEF DESCRIPTION OF THE DRAWINGS

Figure 1 is a schematic flow chart of general example of poultry processing;

Figure 2 is a graph showing the results for the test of bacteriocidal activity of an aqueous hinokitiol solution, wherein CPU in the ordinate axis of the graph means "viable cell ratio;"

Figure 3 is a graph showing the results for the test of contact treatment of an aqueous hinokitiol solution with chicken meat deposited with pathogenic bacteria;

Figure 4 is a graph showing the results for the test of contact treatment of an aqueous hinokitiol solution with chicken meat deposited with pathogenic bacteria;

Figure 5 is a graph showing the results for the test of contact treatment of an aqueous hinokitiol solution with chicken meat deposited with pathogenic bacteria;

Figure 6 is a graph showing the results for the test of contact treatment of an aqueous hinokitiol solution with chicken meat deposited with pathogenic bacteria; and

Figure 7 is a graph showing the results for the test of contact treatment of an aqueous hinokitiol solution with chicken meat deposited with pathogenic

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bacteria.

## DETAILED DESCRIPTION OF THE INVENTION

One of the greatest characteristics of the method of sterilizing poultry meat of the present invention resides in that in the poultry processing for a production of poultry meat, the poultry meat is subjected to a contact treatment with an aqueous hinokitiol solution. By carrying out the method of the present invention in the manner described above, the poultry meat can be sterilized safely and simply, and more continuously and effectively as compared with those of conventional methods.

In other words, since the aqueous hinokitiol solution used in the present invention exhibits an excellent effect on sterilization of poultry meat, poultry meat can be sterilized simply only by contacting poultry meat with the above-mentioned aqueous solution, for example, immersing poultry meat into the above-mentioned aqueous solution. Since there are various problems in the poultry processing different from those of other edible animals as described above, control of microorganisms in the poultry processing is generally difficult. However, poultry meat can be sterilized efficiently, because an aqueous hinokitiol solution exhibits an excellent sterilization effect, and a contact treatment using the above-mentioned aqueous solution can be carried out very simply even over all sorts of poultry meat. In addition, since hinokitiol contained in the aqueous hinokitiol solution is a component derived from natural materials and also excellent in safety, poultry meat after the contact treatment has no toxicity or extremely low toxicity, so that there is no necessity for removing hinokitiol or the aqueous hinokitiol solution from the poultry meat

after the contact treatment. Therefore, an excellent sterilization effect is exhibited continuously even in steps after the sterilization step. Additionally, there would be no influences on human body, equipments, environment and the like suspected in conventional methods.

5           The hinokitiol used in the present invention may be a naturally derived material or a synthetic material. The hinokitiol may be a purified product, or a composition containing hinokitiol. For example, an extract derived from natural plants can also be used. Further, a salt of hinokitiol can also be used.

10           The term "hinokitiol" is generally used as a generic name of  $\beta$ -thujaplicin, one isomer of thujaplicin. The aqueous hinokitiol solution in the present invention may contain other isomers thereof,  $\alpha$ -thujaplicin and  $\gamma$ -thujaplicin, besides  $\beta$ -thujaplicin.

15           The raw material plants of hinokitiol include, for example, white cedar leaf, Taiwanhinoki, Thujopsis dolabrata and the like. Among them, white cedar leaf is preferable from the viewpoint of easy availability. The extraction and purification of hinokitiol from raw material plants can be carried out by a known method. The above-mentioned extract includes, for example, essential oils obtained from the above-mentioned raw material plants (for example, white cedar leaf oil). On the other hand, a synthetic product can also be obtained by a  
20           known method. Commercially available products include, for example, those available from Takasago Perfume Co., Ltd. and Osaka Organic Chemical Ind., Ltd. As the salt of hinokitiol, for example, alkali metal salts such as sodium salts and potassium salts are preferable.

25           Water as a medium of the aqueous hinokitiol solution is not particularly limited. For example, tap water, distilled water, ion-exchanged water and the

like can be used. The concentration of hinokitiol in the aqueous solution varies depending upon the degree of processing and freshness condition of poultry meat which is a subject for applying the method of sterilizing poultry meat of the present invention. The concentration can be appropriately adjusted so that the desired effects of the present invention are obtained. In general, the concentration is preferably from 1 to 50000 ppm, more preferably from 10 to 5000 ppm, still more preferably from 25 to 1000 ppm. The preparation of an aqueous hinokitiol solution can be carried out, for example, by mixing hinokitiol or the above-mentioned extract with water. The other components may be added to the solution as desired. For example, surfactants safe for human body, extracts from plants and the like may be added to the aqueous solution, from the viewpoint, for example, of increase in the solubility of hinokitiol in water.

The poultry applicable for the method of sterilizing poultry meat of the present invention are not particularly limited. The poultry include, for example, chickens, drakes, turkeys, quails, ducks, herons, ostriches, emus and the like. The method of sterilizing poultry meat of the present invention is effective for sterilization of, for example, *Salmonella spp.*, *Staphylococcus aureus*, *Escherichia coli* (for example, *E. coli* O157), *Listeria spp.*, *Campylobacter spp.* and the like, which can be detected in poultry meat. Especially, the method is effective for sterilization of *Salmonella spp.*, *Listeria spp.* and *E. coli* O157.

In the present specification, the phrase "subjecting poultry meat to a contact treatment with an aqueous hinokitiol solution" refers to carrying out an operation capable of contacting poultry meat with an aqueous hinokitiol solution. Concretely, the contact treatment includes preferably subjection of poultry meat to applying a coat, spraying or rubbing with an aqueous hinokitiol solution, or

subjection of poultry meat to immersion in an aqueous hinokitiol solution without being particularly limited. Each of the above-mentioned embodiments for contact treatment may be used alone or in combination of two or more embodiments. In other words, it is preferable that the contact treatment is carried out by at least one selected from the group consisting of application of coating, spraying, rubbing and immersion. Further, in the contact treatment, it is preferable that an aqueous hinokitiol solution is contacted with the entire body of poultry meat. The spraying includes, for example, the following embodiments: An embodiment of showering poultry meat with an aqueous hinokitiol solution; an embodiment of passing poultry meat under a shower of an aqueous hinokitiol solution; an embodiment of spraying an aqueous hinokitiol solution on poultry meat; and an embodiment in which poultry meat are maintained for a given time period in a given zone filled with a mist of an aqueous hinokitiol solution or passed through the zone. Further, the immersion includes, for example, an embodiment of maintaining poultry meat in or passing poultry meat through an aqueous hinokitiol solution.

pH of the aqueous hinokitiol solution used in the contact treatment is preferably from 4 to 11, more preferably from 6 to 8, from the viewpoint of obtaining an excellent effect for sterilizing poultry meat. Also, the treatment temperature is preferably from 0° to 70°C, more preferably from 0° to 60°C, further preferably from 0° to 55°C, from the same viewpoint.

In the method of sterilizing poultry meat of the present invention, the above-mentioned contact treatment is carried out in the poultry processing for a production of poultry meat. The contact treatment is carried out preferably at least in one step in the poultry processing comprising plural treatment steps



(embodiment A), and/or in one interval between consecutive two steps in the treatment steps (embodiment B).

In a preferred embodiment of the present invention, the "treatment step" is selected, for example, from the group consisting of an evisceration step, a chilling step and a wrapping step. The embodiments of the above-mentioned steps are not particularly limited as long as they can be understood in the field of poultry meat production and fields which are technologically related thereto. For example, the evisceration step comprises removing viscera; the chilling step comprises chilling poultry meat by immersing poultry meat in chilling water or exposing poultry meat to chilled air; and the wrapping step comprises taking a slaughtered body apart into portion units such as breasts, and thighs, and wrapping them, respectively.

In the embodiment A, the contact treatment can be carried out, for example, as described below. For example, in the evisceration step and the wrapping step, the contact treatment can be carried out by spraying an aqueous hinokitiol solution on poultry meat. On the other hand, in the chilling step, the contact treatment can be carried out by immersing poultry meat into an aqueous hinokitiol solution chosen as water for chilling the meat used in this step.

Particularly, it is more preferable to carry out the contact treatment in a chilling step. In the case where the contact treatment is carried out in a chilling step, when the poultry meat are, for example, immersed into chilled water as described above, the contact treatment can be easily carried out by using a chilled aqueous hinokitiol solution as chilled water used in the present invention. In the embodiment of the chilling step comprising exposing poultry meat to a chilled air, the contact treatment can be easily carried out under such conditions

by appropriately carrying out at least one selected from the group consisting of applying a coat, rubbing and spraying with an aqueous hinokitiol solution onto poultry meat. In the embodiment of the contact treatment by immersion, the contact time period of an aqueous hinokitiol solution with poultry meat is preferably from 5 to 10 minutes, more preferably from 5 to 30 minutes. In the embodiment of the contact treatment by spraying, when, for example, poultry meat are passed through under a shower of an aqueous hinokitiol solution or poultry meat are maintained at a given time period in a given zone filled with a mist of an aqueous hinokitiol solution or are passed through the zone, the contact time period of an aqueous hinokitiol solution with poultry meat is preferably from 5 to 10 minutes, more preferably from 5 to 30 minutes.

In the embodiment B, the contact treatment can be carried out, for example, as described below. For example, it is preferable that a contact treatment is carried out in the interval between an evisceration step and a chilling step, or in the interval between a chilling step and a wrapping step as described below.

In the case where the contact treatment is carried out in the interval between the evisceration step and the chilling step, it is preferable that, for example, the contact treatment is carried out by spraying or immersion, and it is more preferable that the contact treatment is carried out by spraying. The preferred contact time period of an aqueous hinokitiol solution with poultry meat in this case is the same as those define above.

In the case where the contact treatment is carried out in the interval between the chilling step and the wrapping step, it is preferable that, for example,

the contact treatment is carried out by immersion. Concretely, the following embodiments are exemplified.

In the case where the chilling step is carried out by using chilled water, a water film is formed on the surface of poultry meat and a large amount of water is retained in an abdominal cavity, which is formed by removing viscera. Therefore, pre-draining is carried out by, for example, applying vibration, rotation or the like to poultry meat over a period of about several dozens of seconds by any methods. By carrying out this step, the dilution of an aqueous hinokitiol solution used can be preferably prevented in the subsequent contact treatment.

The contact treatment is carried out by placing an aqueous hinokitiol solution into a vessel having a desired size depending upon the amount of poultry meat to be sterilized, and immersing poultry meat subjected to pre-draining into the aqueous hinokitiol solution in this vessel. For example, 1 kg of poultry meat are immersed in 3 liters of an aqueous hinokitiol solution (hinokitiol concentration: 125 ppm) at 0°C for preferably from 5 to 10 minutes, more preferably from 5 to 30 minutes. It is preferable that the above-mentioned vessel is equipped with a stirrer, from the viewpoint of accelerating impregnation of an aqueous hinokitiol solution into poultry meat.

It is preferable that the draining of poultry meat is carried out after the contact treatment as post-draining in the same manner as the above-mentioned pre-draining, and that a surplus amount of the aqueous hinokitiol solution is recovered to reuse the solution in the above-mentioned contact treatment, from the economical viewpoint.

After the contact treatment is carried out as described above, a wrapping step is then carried out.

As described above, in the method of sterilizing poultry meat of the present invention, it is especially preferable that the contact treatment is carried out at least in one point selected from the group consisting of the interval between the evisceration step and the chilling step, the chilling step, and the interval between the chilling step and the wrapping step, from the viewpoint of obtaining desired effects of the present invention.

In addition, as one embodiment of the present invention, there is provided a method for producing poultry meat comprising the step of sterilizing poultry meat by the method of sterilizing poultry meat of the present invention in the poultry processing. According to the method for producing poultry meat mentioned above, poultry meat having higher safety which are highly sterilized as compared with those by conventional methods can be produced efficiently.

The hinokitiol used in the present invention has higher safety, and is accepted as a food additive, and the amount thereof is not limited by Shokuhin Eisei Ho (Japanese Food Sanitation Act). Therefore, the poultry meat can be sterilized safely according to the present invention. Further, an effect of sterilizing poultry meat can be indirectly enhanced by, for example, spraying an aqueous hinokitiol solution to equipments and working environments used for the poultry processing.

## EXAMPLES

The present invention will be described in further detail by means of the following examples without intending to limit the scope of the present invention thereto.

5     Example 1   Test of Bacteriocidal Activity of Aqueous Hinokitiol Solution

          An aqueous hinokitiol solution (pH 4 to 11) having a hinokitiol concentration of 500 ppm was prepared. The bacteriocidal activity of an aqueous hinokitiol solution on *Escherichia coli* at various pH values was tested by using the above aqueous solution as a test solution. The test method is as described below.

          (Test Method)

          A test strain (*Escherichia coli* IFO 12529) cultured in a normal bouillon medium was 100-fold diluted with sterilized water. The amount 0.05 mL of this diluted solution was inoculated to each test solution (5 mL), and thoroughly stirred. The mixture was allowed to stand still at room temperature. After 10 minutes, a 0.1 mL portion of the mixed solution was added to 4.5 mL of physiological saline, and the mixture was then stirred, and immediately, the viable cell count in the physiological saline was determined. As a control, physiological saline was used in place of the test solution. The viable cell count was determined by *Eisei Shiken Ho, Chukai (Sanitation Test Method, Commentary)* (1990), *Biseibutsu Shiken Ho (Microorganism Test Method)*, Chapter 3: Viable Cell Count, Section 1: Konshaku Heiban Baiyo Ho (Mixing-Dilution Plate Culture) (p 148).

The results are shown in Figure 2. It is seen from Figure 2 that an aqueous hinokitiol solution having pH from 4 to 11 shows a sterilization effect on *Escherichia coli*, and especially an aqueous hinokitiol solution having pH from 6 to 8 shows an excellent sterilization effect on *Escherichia coli*.

#### Example 2 Test of Contact Treatment of Aqueous Hinokitiol Solution to Chicken Meat Deposited with Pathogenic Bacteria

A sterilization effect of hinokitiol was evaluated by subjecting chicken meat deposited with pathogenic bacteria to a contact treatment with an aqueous hinokitiol solution [trade name; G Clean-f (hinokitiol concentration: 10000 ppm), manufactured by K.K. JCS]. The test method is as described below.

##### (Test Method)

Ten milliliters of each suspension of various pathogenic bacteria given below was inoculated randomly at several points of 300 g of chicken meat in the processing (meat after a chilling step), and after the inoculation, the meat was frozen at a temperature from 4° to 6°C for 24 hours.

Various pathogenic bacteria and the viable cell count per 1 mL of each of the various pathogenic bacterium suspensions are as follows.

<i>Escherichia coli</i> O157:H7 (IFO 12529) :	$1.933 \times 10^7$ /mL
<i>Salmonella typhimurium</i> (IFO 3972):	$1.807 \times 10^6$ /mL
<i>Listeria monocytogenes</i> (ATCC 7644):	$1.75 \times 10^6$ /mL
<i>Staphylococcus aureus</i> (ATCC 25923):	$1.167 \times 10^6$ /mL
<i>Campylobacter coli</i> (ATCC 43136):	$1.06 \times 10^6$ /mL

The chicken meat inoculated with the above-mentioned various pathogenic bacterium suspensions was separated into three groups Group A, Group B and Group C, three pieces for each group. Subsequently, Group A was immersed in 3 L of ion-exchanged water at 10°C and stirred by a hand with a sterilized glove for 5 minutes. Group B was immersed into 3 L of an aqueous hypochlorite solution (50 mg/L) and stirred for 5 minutes in the same manner as in Group A. Group C was immersed into 3 L of a 80-fold diluted aqueous solution of G Clean-f at 10°C and stirred for 5 minutes.

After immersion, the chicken meat was drained for 1 minute, and placed into a sterilized nylon bag containing 300 mL of Butterfield's phosphate buffer solution, and bacteria were suspended into the buffer to obtain test solution. This test solution was applied onto an agar medium in a petri dish, and the bacteria were cultured at 35°C for 24 to 48 hours. After culturing, the viable cell count was determined by a conventional method. The results are shown in Table 1 and Figures 3 to 7. In the table and figures, the viable cell count indicates the viable cell count per 1 mL of the pathogenic bacterium suspension or test solution.

Table 1

Viable Cell Count	A	B	C
<i>E. coli</i>	$3.0 \times 10^5$ /mL	$1.67 \times 10^5$ /mL	$4.35 \times 10^4$ /mL
<i>S. typhimurium</i>	$1.13 \times 10^6$ /mL	$1.6 \times 10^5$ /mL	$1.4 \times 10^5$ /mL
<i>L. monocytogenes</i>	$1.94 \times 10^5$ /mL	$3.35 \times 10^4$ /mL	$1.04 \times 10^3$ /mL
<i>S. aureus</i>	$3.0 \times 10^4$ /mL	$2.2 \times 10^4$ /mL	$1.4 \times 10^4$ /mL
<i>Campylo: coli</i>	$2.55 \times 10^3$ /mL	$9.5 \times 10^2$ /mL	$4.0 \times 10^2$ /mL

It is seen from Table 1 and Figures 3 to 7 that a more excellent sterilization effect is obtained when the poultry meat are immersed into an aqueous hinokitiol solution as compared with those immersed into an aqueous hypochlorite solution used in conventional sterilization methods.

According to the present invention, the poultry meat can be sterilized safely and simply, and continuously and effectively.

The present invention being thus described, it will be obvious that the same may be varied in many ways. Such variations are not to be regarded as a departure from the spirit and scope of the invention, and all such modifications as would be obvious to one skilled in the art are intended to be included within the scope of the following claims.